Basement Insulation

Introduction

If your home has an uninsulated basement, you are paying up to 30 per cent more for heating than if it were insulated. **Earth around the basement is not a good insulator and the concrete conducts heat out.** Cracks and holes in the foundation wall and the rim joist area allow warm air to leak out. (Figure 1). This could mean $150 or more lost each year through unnecessary heating costs. Compare this to the approximate cost of $850 for framing and insulating materials to insulate a basement on the inside, or $1100 for materials to insulate outside the foundation of a 110 square metres (1200 square feet) bungalow.

An insulated basement improves its livability making it more comfortable and evenly heated.

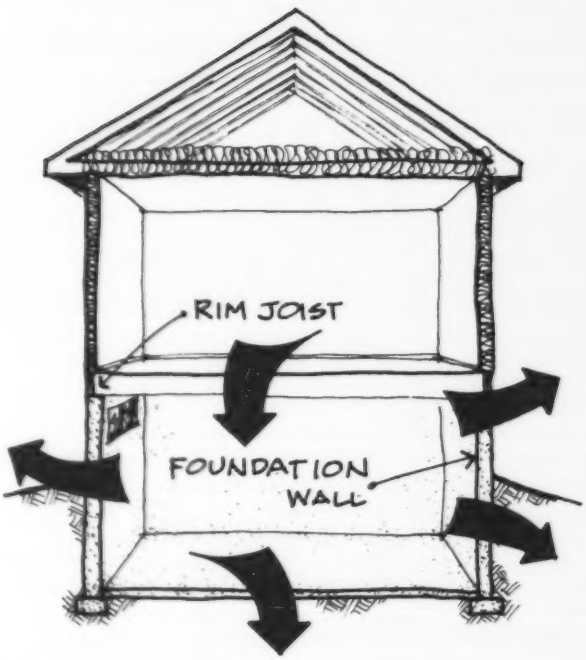

Figure 1

Two Methods of Insulating

	Advantages	Disadvantages
Interior	• Smooth wall for easy finishing • Done in any weather • Space for wiring and plumbing • Landscape undisturbed • Can be done in stages to accommodate budget	• Interior finishing may already be complete • Difficult if ducts and pipes are against wall • Water lines must be inside insulated wall to avoid freezing • Difficult to seal air/vapour barrier in floor joist area • Decreases basement area
Exterior	• No disturbance of interior • Interior water lines protected • No loss of basement area • Even temperature reduces thermal stress on concrete • Cracks or leaks can be repaired • Fibrous rigid insulation can act as additional drainage aid • Basement wall acts as thermal mass, storing heat in the house • Effective way to insulate joist area • Allows placement of missing or damaged weeping tile	• Requires extensive digging • Difficult near patios, steps, decks • Disturbs landscaping • Excavation is physically demanding • Shifting or settling can damage insulation • Must be done in warm weather • Uses more expensive materials • Must be completed quickly in case of flooding

You can insulate basement walls on the inside or the outside. This table compares the advantages and disadvantages of each method.

Review the pros and cons and determine the better solution for you.

Before you Start

Familiarize yourself with the basic parts of a foundation wall (Figure 2). The drawing shows an older construction method where floor joists are embedded in the concrete foundation. The more common technique is platform framing, where floor joists rest on top of a wood plate that in turn rests on the foundation.

Upgrading insulation and wall finishes are considered an "improvement". Check with your local building inspector to obtain any necessary building or development permits. The Alberta Building Code requires that new homes have a minimum RSI value (metric insulation value, the higher the better) of 1.4 which is equivalent to R 8 (imperial insulation value) from the top of the basement wall down to 600 mm (24 inches) below ground level. We recommend an RSI value of 2.1 to 3.5 (R 12 to R 20) down the complete wall for greater energy saving and comfort.

Check for leaks before insulating. Minor leaks can often be repaired from the inside with quick setting epoxy waterproofing compounds (available at building supply outlets). Serious water leakage requires repair from the outside.

This publication describes the most common method, insulating from the interior. Information is included on exterior insulation, but for details contact manufacturers or local distributors of exterior insulations.

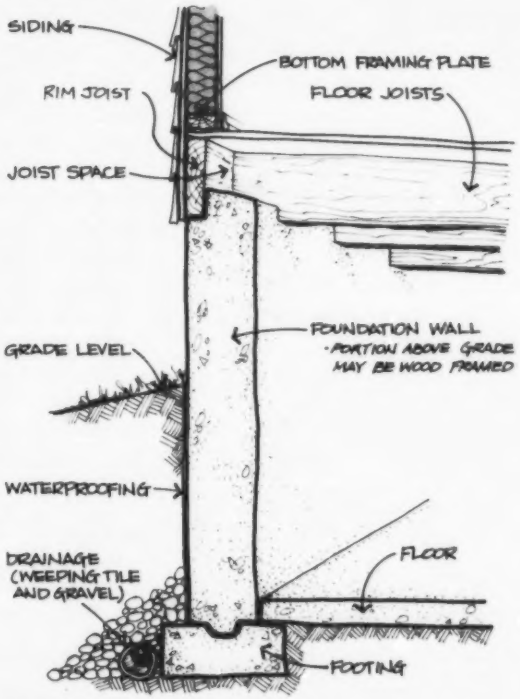

Figure 2

Interior Basement Insulation

If your basement has had no work done on it, starting the job is easy. Chances are some wall finishing has been done. If there is no proper air/vapour barrier and little or no insulation, it is best to remove these finishes. This allows you to check for moisture and to adequately seal and insulate the joist space.

Two Methods of Insulating the Interior

1. The most common uses wall framing filled with glass fibre batts. This method is described here in detail.

2. The second involves fastening rigid board insulation to the wall. A number of fastening systems are available. Check with the local distributor or manufacturer of rigid insulation material for its recommended method of application. **Note: the Alberta Building Code requires foamed plastic materials to be covered with a fireproof layer of drywall or plaster.**

Tools

- basic carpentry tools
- sharp knife
- caulking gun, stapler
- drill, masonry bit and concrete anchors
- safety and protection equipment: a hard hat, goggles, gloves and a breathing mask should be used when working with power tools and installing some insulation materials

Sealing the Walls

It is easier to seal wall and joist spaces before you start framing or applying rigid insulation. Figure 3 shows where to caulk in sill-plate and rim joist areas. Be sure to seal around wires, pipes, ducts or conduits that penetrate walls or rim joists. Fill larger gaps with a foam backer rod or polyurethane spray foam to provide a solid backing for caulking (Figure 4).

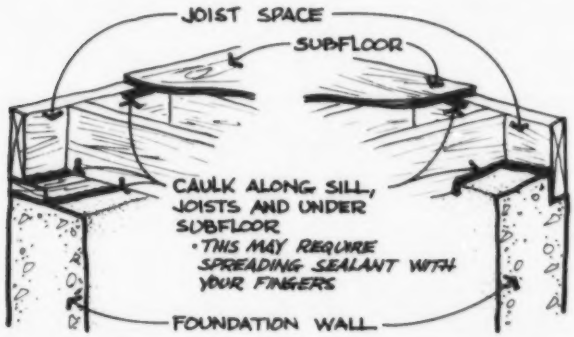
JOIST SPACE
SUBFLOOR
CAULK ALONG SILL, JOISTS AND UNDER SUBFLOOR
• THIS MAY REQUIRE SPREADING SEALANT WITH YOUR FINGERS
FOUNDATION WALL

Figure 3

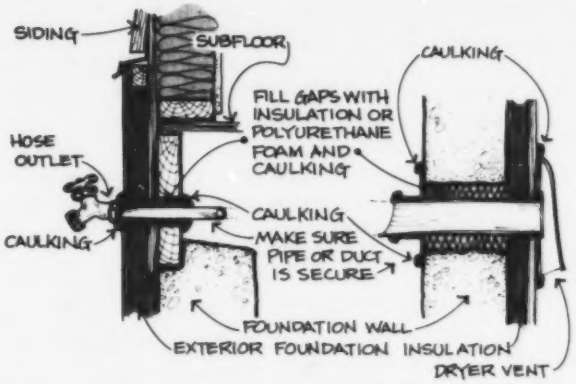

Figure 4

Canned polyurethane foam can be used as an alternative to caulking to both seal and insulate larger gaps. **It must be covered with 13mm (one-half inch) drywall or equivalent for fire protection if exposed to the inside of the house.**

Use a good quality, durable caulking material that is compatible with concrete. See *Caulking and Weatherstripping*, of this series, for more information on caulking materials and methods of application.

Moisture Barrier

The moisture barrier is generally placed on the inside of the foundation wall to protect the insulation and framing materials from water damage. There is controversy over the necessity of the moisture barrier. In newly poured basements the large amount of moisture in the concrete can collect behind a polyethylene moisture barrier, run down the barrier and out the bottom. If the basement is finished there may be damage to the flooring. To avoid this, either leave the basement walls open for one year to dry out or insulate from the exterior.

In older basements the moisture barrier provides insurance against water damage in the wall. Whether it is necessary depends on the type of drainage and soil around the foundation.

The moisture barrier is usually polyethylene or a waterproof coating. It must extend from the ground or grade level down to the basement floor and under the bottom plate. **It is important that this barrier extend only up to the grade line to prevent trapping moisture within the framed wall (Figure 5).**

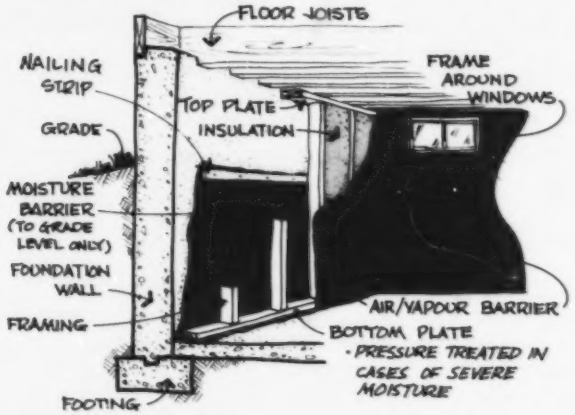

Figure 5

Polyethylene is attached to the wall with acoustical sealant and a plywood nailing strip. If a waterproof coating is used, it is painted or sprayed on the basement wall before construction. In both cases, the bottom plate of the framing should be protected from the concrete with a strip of polyethylene (Figure 6).

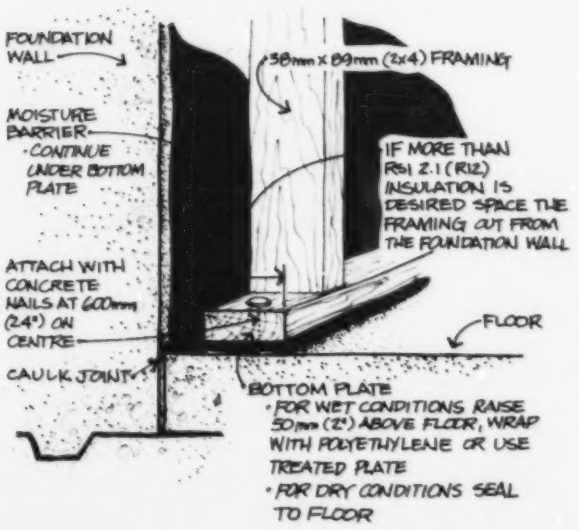
FOUNDATION WALL
38mm x 89mm (2x4) FRAMING
MOISTURE BARRIER
• CONTINUE UNDER BOTTOM PLATE
IF MORE THAN RSI 2.1 (R12) INSULATION IS DESIRED SPACE THE FRAMING OUT FROM THE FOUNDATION WALL
ATTACH WITH CONCRETE NAILS AT 600mm (24") ON CENTRE
FLOOR
CAULK JOINT
BOTTOM PLATE
• FOR WET CONDITIONS RAISE 50mm (2") ABOVE FLOOR, WRAP WITH POLYETHYLENE OR USE TREATED PLATE
• FOR DRY CONDITIONS SEAL TO FLOOR

Figure 6

Wall Framing

Use wall framing of 2 x 4's at 400mm (16 inches) or 600mm (24 inches) on centre to provide an insulation cavity, wiring space and support for the interior finish. The interior face can be placed 90mm (3.5 inches) in from the foundation wall for RSI 2.1 (R 12) batt insulation or 140mm (5.5 inches) for RSI 3.5 (R 20) batt insulation. Use a single top and bottom plate and single members around windows. There are many books, such as *Canadian Wood Frame House Construction*, available from Canada Mortgage and Housing Corporation (CMHC) showing framing techniques. If the foundation wall and floor are always dry, seal the bottom plate to the floor. Use caulking or a gasket material to prevent warm air from leaking under and up the foundation wall behind the insulation.

Bilevel homes are a special case. Two techniques for framing them are shown in Figure 7.

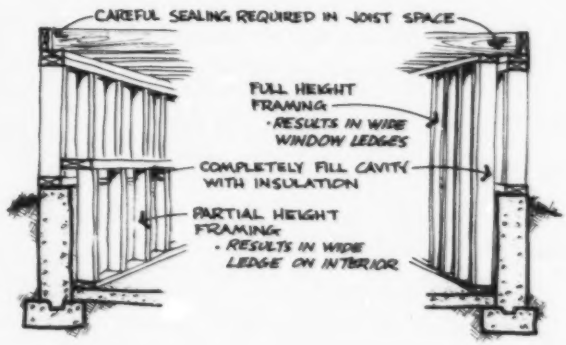
CAREFUL SEALING REQUIRED IN JOIST SPACE
FULL HEIGHT FRAMING
• RESULTS IN WIDE WINDOW LEDGES
COMPLETELY FILL CAVITY WITH INSULATION
PARTIAL HEIGHT FRAMING
• RESULTS IN WIDE LEDGE ON INTERIOR

Figure 7

Framing around stair wells and landings may also pose problems.

A cold storage room will not require framing on the outside walls but should be sealed off from the rest of the basement. Each situation is unique and you may have to improvise. **Always place the air/vapour barrier on the warm side of the insulation.**

If possible, place the framing behind any pipes or ducts close to the foundation walls to prevent freezing (Figure 8). **Be sure not to leave any pipes or drains on the outside of the insulation layer.** Many plumbing reference books outline simple drainage and water line renovations, if moving them is necessary.

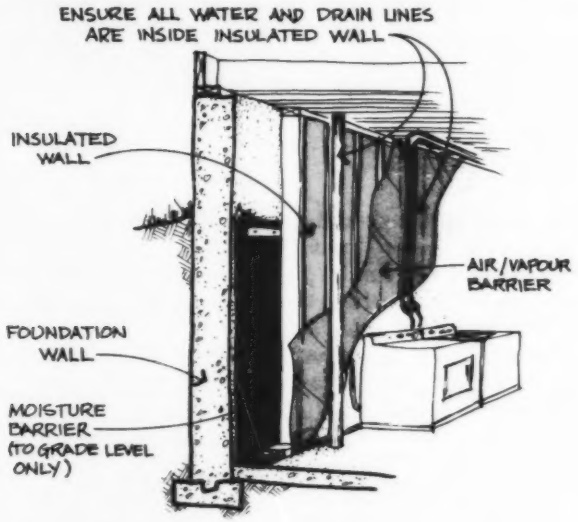
ENSURE ALL WATER AND DRAIN LINES ARE INSIDE INSULATED WALL
INSULATED WALL
AIR/VAPOUR BARRIER
FOUNDATION WALL
MOISTURE BARRIER (TO GRADE LEVEL ONLY)

Figure 8

Electrical panels or gas and water meters may pose particular problems. Moving them requires qualified personnel and may be expensive. The simplest solution is often to just insulate and frame as closely as possible to the unit. Thinner rigid insulation pieces may be slipped behind pipes or lines.

Be careful near electrical panels since they are still "live" even when the main switch is off.

Electrical work can be done by a qualified electrician or the capable homeowner (reference books are available to aid in wiring design and layout). Be sure to obtain the necessary permits and inspections.

Switch, outlet and junction boxes on outside walls should have an air/vapour barrier installed behind them.

Before proceeding, check again to make sure any holes in joist spaces or walls have been caulked to prevent air leakage.

Wall Insulation

Batt insulation is usually used because it is relatively inexpensive and easy to install in stud spaces. The stud spaces must be completely filled to prevent heat loss caused by air movement behind the insulation. Make sure you cut the insulation pieces to exact size. Do not fold or overlap any pieces to make them fit.

Be sure to fill the joist space cavity as well. Figure 9 shows different joist space configurations and has suggestions for insulating and sealing. Note: in wall type "C", an air space is required above the insulation to avoid a cold floor perimeter.

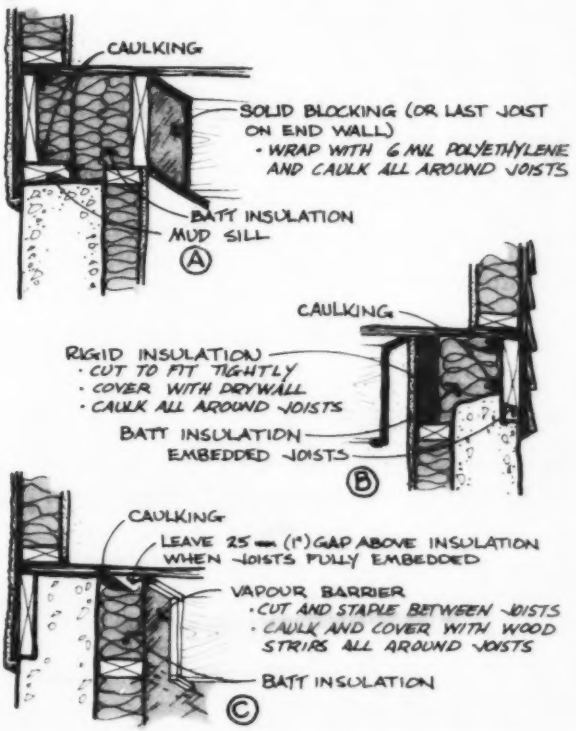
CAULKING
SOLID BLOCKING (OR LAST JOIST ON END WALL)
· WRAP WITH 6 MIL POLYETHYLENE AND CAULK ALL AROUND JOISTS
BATT INSULATION
MUD SILL
A
CAULKING
RIGID INSULATION
· CUT TO FIT TIGHTLY
· COVER WITH DRYWALL
· CAULK ALL AROUND JOISTS
BATT INSULATION EMBEDDED JOISTS
B
CAULKING
LEAVE 25 mm (1") GAP ABOVE INSULATION WHEN JOISTS FULLY EMBEDDED
VAPOUR BARRIER
· CUT AND STAPLE BETWEEN JOISTS
· CAULK AND COVER WITH WOOD STRIPS ALL AROUND JOISTS
BATT INSULATION
C

Figure 9

Insulate the walls between a cold storage room and the heated basement. The ceiling of a cold storage room must also be insulated. If there are floor overhangs, as in many bilevels or under bay or bow windows, seal well and insulate as shown in Figure 10.

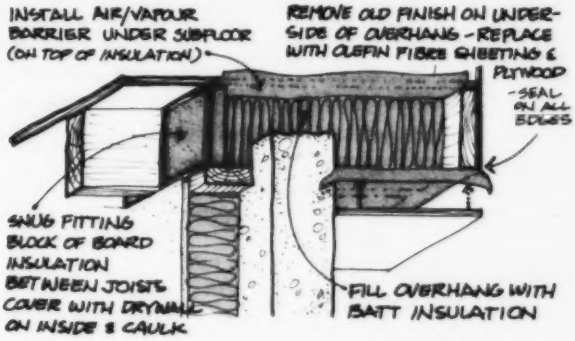
INSTALL AIR/VAPOUR BARRIER UNDER SUBFLOOR (ON TOP OF INSULATION)
REMOVE OLD FINISH ON UNDERSIDE OF OVERHANG - REPLACE WITH OLEFIN FIBRE SHEETING & PLYWOOD - SEAL ON ALL EDGES
SNUG FITTING BLOCK OF BOARD INSULATION BETWEEN JOISTS COVER WITH DRYWALL ON INSIDE & CAULK
FILL OVERHANG WITH BATT INSULATION

Figure 10

Before proceeding, survey the wall insulation to make sure all areas have been filled. Check that the joist space has been insulated properly. **Make sure no pipes or ducts are on the cold side of the insulation.**

Air/Vapour Barrier

An air/vapour barrier is essential on the inner, or warm, surface of an exterior wall. This barrier can be provided by 0.15mm (6 mil) polyethylene. Staple the polyethylene to the framing, using only enough staples to hold it in place. Don't pull tight.

All joins should overlap one joist or stud space (Figure 11). Caulk all edges and overlap with a non-skinning acoustical sealant. Overlaps, joins or edges can be reinforced with a strong tape before stapling.

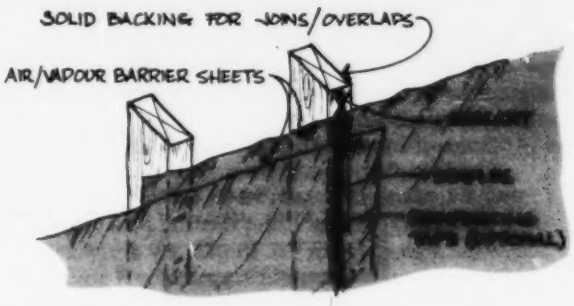

Figure 11

Electrical outlets should be enclosed with polyethylene before installation. A commercial polyethylene box can be purchased or made up of loose polyethylene. Seal the edges of the box to the wall air/vapour barrier. Also seal the barrier around window and exterior door openings (Figure 12) and in the joist space using one of the methods shown in Figure 9.

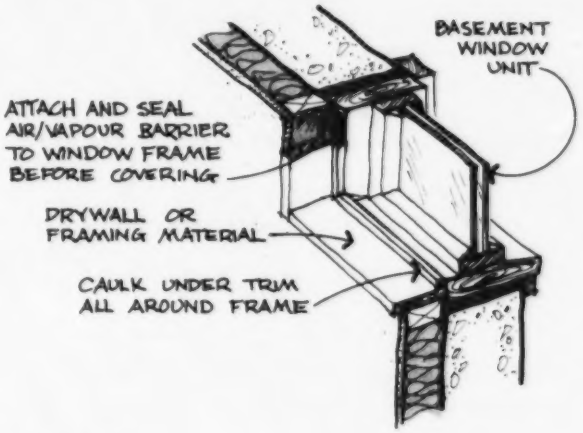
BASEMENT WINDOW UNIT
ATTACH AND SEAL AIR/VAPOUR BARRIER TO WINDOW FRAME BEFORE COVERING
DRYWALL OR FRAMING MATERIAL
CAULK UNDER TRIM ALL AROUND FRAME

Figure 12

A new method, called the Airtight Drywall Approach (A.D.A.), uses properly installed and treated drywall as the air/vapour barrier. To install a drywall air/vapour barrier, place a strip of gasket material along the bottom and side of the bottom plate (Figure 13). Recommended gasket materials include closed-cell neoprene and saturated urethane foams. Notch the drywall around the floor joists to provide a tight fit. With caulking seal the drywall to the subfloor and the floor joists. Finally, tape the drywall and finish it with a vapour-barrier paint.

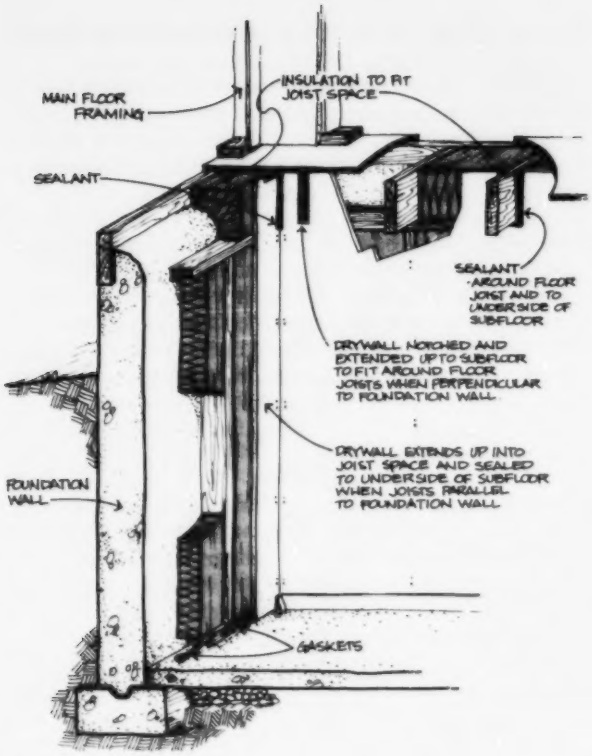
MAIN FLOOR FRAMING
INSULATION TO FIT JOIST SPACE
SEALANT
SEALANT AROUND FLOOR JOIST AND TO UNDERSIDE OF SUBFLOOR
DRYWALL NOTCHED AND EXTENDED UP TO SUBFLOOR TO FIT AROUND FLOOR JOISTS WHEN PERPENDICULAR TO FOUNDATION WALL
DRYWALL EXTENDS UP INTO JOIST SPACE AND SEALED TO UNDERSIDE OF SUBFLOOR WHEN JOISTS PARALLEL TO FOUNDATION WALL
FOUNDATION WALL
GASKETS

Figure 13

It is important to create as complete an air/vapour barrier as possible. Make sure you do not accidentally puncture the barrier. Repair any tears or holes in the polyethylene or drywall.

There are no limitations on wall or ceiling coverings unless foamed plastic materials are used. **These products must be covered for fire protection with 13mm (one-half inch) drywall which is securely anchored to the structure.** Suspended ceiling systems provide convenient access if repair work is required on ducts or pipes.

Exterior Basement Insulation

Retrofitting a basement from the outside is less common because of the extra work, the mess and the high cost. However, for new homes or existing homes requiring major foundation repairs exterior insulating is practical.

Exterior insulating requires digging around the foundation. Mark the location and depth of utility services -- underground electrical services, gas piping, telephone and cable TV hook-ups. Local utility companies provide this information.

Two Methods of Insulating the Exterior

1. Partial depth method: place insulation against the wall down to 300mm (12 inches) below ground. Then place insulation 900 to 1200mm (36 to 48 inches) horizontally to control lower wall heat loss. Note: in new home construction, the Alberta Building Code requires vertical insulation down to 600mm (24 inches) below ground level, either inside or outside the wall.

2. Full depth method: place insulation vertically down entire wall to the footings. This method is preferable as it is more effective in reducing heat loss but more difficult because a deeper trench is required.

Tools for the job

- shovels, pick and wheelbarrow for the excavation
- scraper and stiff brush to clean outside of exposed foundation wall
- short bristle paint brush to apply waterproofing materials
- standard carpentry tools
- drill, concrete bit, masonry nails or anchors (if attachment to concrete is required)
- power hand saw and masonry blade if cutting stucco is required
- safety equipment such as goggles, gloves and hard hat should be used when working with power tools.

Wall Preparation

Dig a trench around the foundations (Figure 14). Clean the exposed wall of dirt or other debris with brush or scraper. **If the black waterproofing is dry, cracked or missing, repair the area.** Building supply stores stock bituminous (tar) coatings for this purpose. Allow new waterproof coatings to dry completely before applying insulation.

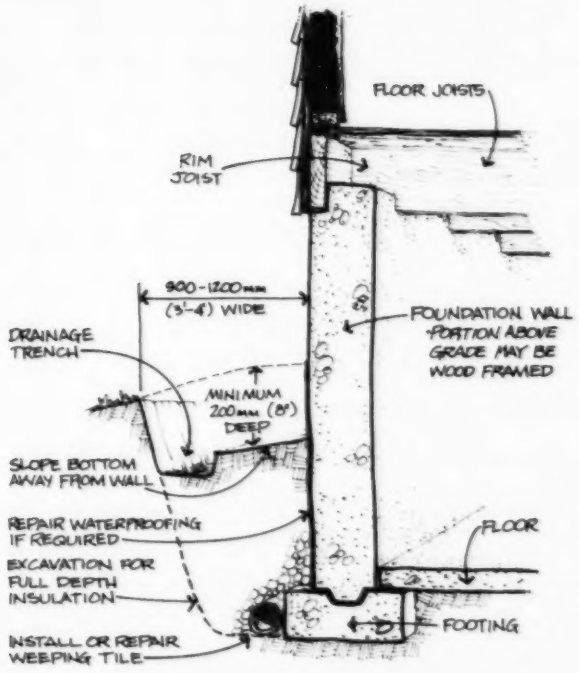

Figure 14

Inspect all wall penetrations and surface-mounted fixtures such as exhaust vents, electrical outlets, hose bibs and gas lines. These should be sealed with grout or silicone sealant. If possible, extend fixtures out from the wall to accommodate the insulation. **Use qualified tradespeople to move gas or electrical fixtures.**

Carefully remove the lower portion of the siding or stucco. The top edge of the outside insulation should be a few centimetres above the line of the subfloor ensuring both the joist space and the wall below will be completely insulated. It also allows you to caulk around the rim joist where it meets the upper and lower floor.

Leave the lower edge of the siding or stucco and building paper pulled away from the wall a few millimetres from the wall so that flashing (called drip cap or J-channel) can be installed beneath it. The flashing allows the insulation to extend beyond the line of the siding or stucco and protects the insulation from rain. The flashing should be wide enough to cover both insulation and protective coating.

Slip the flashing into place under the existing siding or stucco and building paper before the wall insulation is installed. The bottom siding nails may have to be removed before slipping the flashing in place. After the insulation and protective covering are in place, lower the flashing slightly and attach with roofing nails. The secured flashing provides a waterproof cap for wall insulation and wall joint.

It may not be possible to remove the stucco or siding above the level of the subfloor. Place the outside insulation as high as possible. The uninsulated portion, usually the rim joist, can be insulated and sealed on the inside (see page 5).

Wall Insulation

These types of materials are used for insulating outside foundation walls: extruded or expanded polystyrene and rigid glass fibre. Expanded polystyrene, also known as beadboard, is available in different densities. **Type 1 has the lowest density and is not recommended for below grade applications.**

Extruded and expanded (except for Type 1) polystyrene can be used underground for both vertical and horizontal applications. Rigid glass fibre can only be used vertically against the wall.

The method for applying rigid insulation to basement walls depends on the type and thickness of the insulation and the soil conditions. Check with your local distributor or the manufacturer for recommendations. Because of the work involved you should insulate to a minimum of RSI 1.2 (R 7).

Wall Covering

The insulation must be protected to avoid damage from lawnmowers or garden tools. Some rigid insulation materials will deteriorate if not protected from prolonged exposure to sunlight. Various materials can provide a protective covering: pressure-treated plywood, cement board, acrylic stucco, cement, brick and treated siding.

Stucco can be applied on wire lath attached directly to the rigid insulation. Some new products do not require the wire lath. Stucco can also be applied over plywood sheathing. Wear hand and eye protection when working with wire lath.

Siding materials such as plywood or cement board can be applied over 38mm (1.5 inch) rigid insulation. Wood strapping at the top and a ledger strip at the bottom makes this method more reliable. To attach over thicker insulation, support framing must be built to provide a nailing surface (Figure 15). You can also use siding or stucco over pressure-treated plywood. The treated plywood should extend below ground level to provide added insulation protection. Pressure-treated plywood can be painted to provide an inexpensive finish.

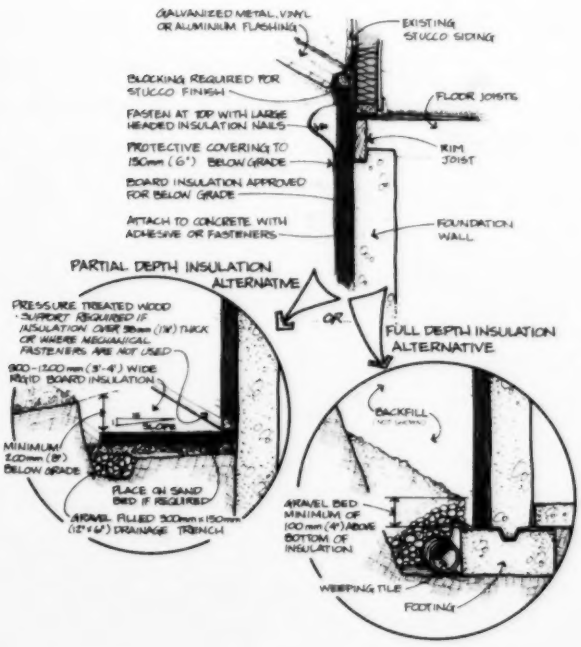
GALVANIZED METAL, VINYL OR ALUMINUM FLASHING
EXISTING STUCCO SIDING
BLOCKING REQUIRED FOR STUCCO FINISH
FLOOR JOISTS
FASTEN AT TOP WITH LARGE HEADED INSULATION NAILS
PROTECTIVE COVERING TO 150mm (6") BELOW GRADE
RIM JOIST
BOARD INSULATION APPROVED FOR BELOW GRADE
ATTACH TO CONCRETE WITH ADHESIVE OR FASTENERS
FOUNDATION WALL
PARTIAL DEPTH INSULATION ALTERNATIVE
OR
FULL DEPTH INSULATION ALTERNATIVE
PRESSURE TREATED WOOD SUPPORT REQUIRED IF INSULATION OVER 38mm (1½") THICK OR WHERE MECHANICAL FASTENERS ARE NOT USED
900 - 1200 mm (3'-4') WIDE RIGID BOARD INSULATION
SLOPE
MINIMUM 600mm (2') BELOW GRADE
PLACE ON SAND BED IF REQUIRED
GRAVEL FILLED 300mm x 150mm (12" x 6") DRAINAGE TRENCH
BACKFILL
GRAVEL BED MINIMUM OF 100 mm (4") ABOVE BOTTOM OF INSULATION
WEEPING TILE
FOOTING

Figure 15

Floor Insulation

Although basement floor insulation may be hard to justify from an energy saving point of view (unless you have radiant floor heating) it can increase the comfort level considerably. Carpet with thick underlay provides a minimum level of thermal comfort. A more effective but expensive method is to build an insulated subfloor, or sleeper floor.

A word of caution. Ensure the basement is dry before insulating the floor. Check for moisture by placing a square of polyethylene at several locations on the floor. Seal the edges with masking tape. If a damp spot occurs within 24 hours, the floor is too moist.

Place a polyethylene moisture barrier on the concrete to prevent the transfer of moisture to the subfloor (Figure 16). Frame and insulate the subfloor with batts or rigid board insulation. Shim the sleepers as required to obtain a level surface. Apply an air/vapour barrier, and then install plywood sheeting and floor covering.

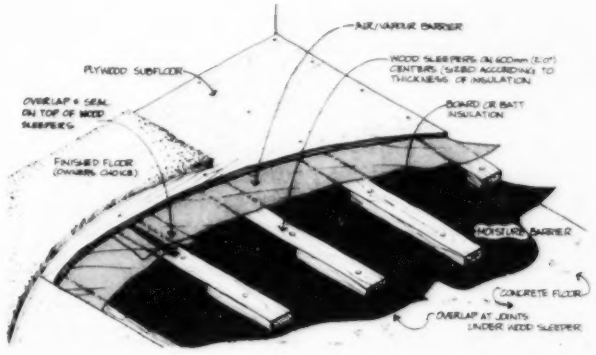
AIR/VAPOUR BARRIER
PLYWOOD SUBFLOOR
WOOD SLEEPERS ON 600mm (2'-0") CENTERS (SIZED ACCORDING TO THICKNESS OF INSULATION)
OVERLAP & SEAL ON TOP OF WOOD SLEEPERS
BOARD OR BATT INSULATION
FINISHED FLOOR (OWNERS CHOICE)
MOISTURE BARRIER
CONCRETE FLOOR
OVERLAP AT JOINTS UNDER WOOD SLEEPER

Figure 16

Summary

- Choose between exterior or interior basement insulation.
- Decide on materials, including existing materials that can be salvaged. Measure your requirements and obtain cost estimates. Obtain permits for changes to the building and the electrical system.
- For interior method:
  - seal wall and joist space
  - apply moisture barrier (to grade level only)
  - frame wall and make required electrical, plumbing and heating changes
  - apply insulation
  - apply air/vapour barrier
- For exterior method:
  - excavate and clean wall of dirt and debris
  - remove siding or stucco to level required
  - insulate wall by selected method
  - apply wall insulation protection
  - backfill excavation carefully
  - install siding and flashing protection
- Consider insulating the floor to provide extra comfort.

Now you can enjoy the benefits of the basement insulation project and appreciate energy and money savings and increased comfort and living space.

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Basement Insulation

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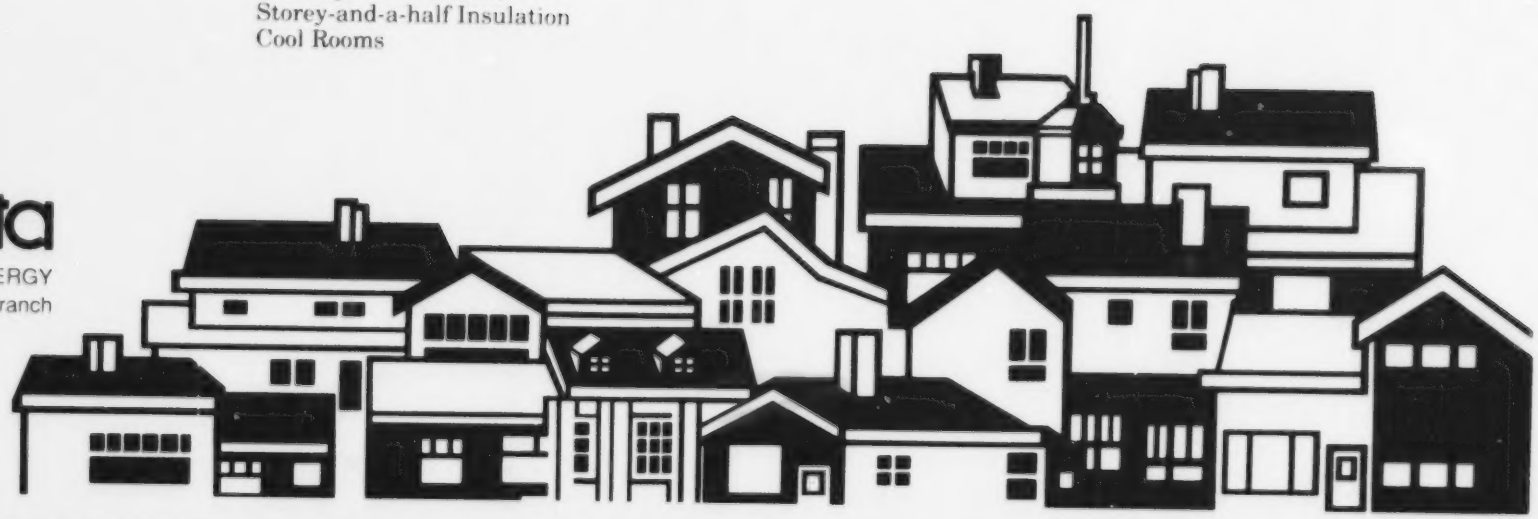
New Homes
Passive Solar
Wood Heating
Crawlspace Insulation
Storey-and-a-half Insulation
Cool Rooms



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